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Design of Treadmill to Generate Electricity by using Mechanical Energy

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ABSTRACT

In day to day life human being suffering from the health problems and stress. Another problem faced by the world is difference between energy generation and energy consumption. We can examine some aspects in our observation to save energy. Like to run on treadmill power supply is given for ease of running and for showing the parameters. But what about our human power, that is going to waste. To store that energy into electric energy the mechanism of treadmill will be develop such that the rotary motion of roller transforms energy to the generator by coupled it with belt. By this type of arrangement the health problems and energy problems can be solved. The stored energy can be used for various purpose and we not only save the energy required for treadmill but also generates the energy from using treadmill.

Keywords: *Health problems[1], energy consumption[2], human power[3], electric energy[4], treadmill[5]*

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1. INTRODUCTION

A treadmill is a device basically used for running and to loss calories. Now a day because of business of human being in their day to day work, they feel tired to go for run. But health problems occurred due to stressful life and obesity occurs in many of them. For ease of running and to know the how much calories burn and for running at same place treadmill was developed. Treadmill provides a moving platform with a wide conveyor belt (track), driven by an electric motor. The belt moves to the roller, requiring the user to walk or run at a speed matching that of the belt. The rate at which the belt moves is the rate of walking or running. Thus, the speed of running may be controlled and measured by using controller and sensors provided. The more expensive, heavy duty versions are motor-driven(usually driven by an electric motor). And manual treadmills without motor are less expensive but require more human efforts for moving the belt on roller. In most of the gym premises expensive and motor driven treadmill used.

For generation of energy by using treadmill we have to use manual treadmill to save energy and to minimize cost.

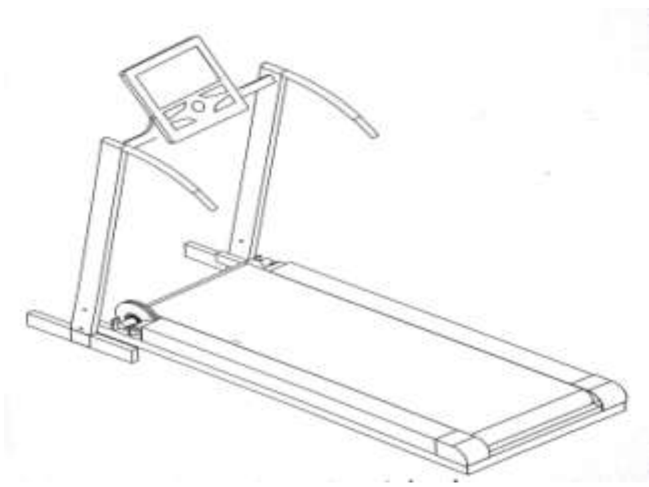

Fig.1: Manual Treadmill

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2. Literature Review:

A K Katiyar, S T Murtaza& S Ali has conclude this treadmill with Electricity Generator is useful for such areas where electricity is not available and also Electrical energy can be saved by using this manual treadmill with Electricity Generator**.**

Harsh Mankodi has concluded a treadmill based human power generator was developed using an Electromagnetic dynamo generator coupled to a manual treadmill's flywheel. The final circuit delivering power to a heavy duty battery was found to be able to deliver 140 W peak for a short period of time.

3. Design :

3.1 Flowchart:-

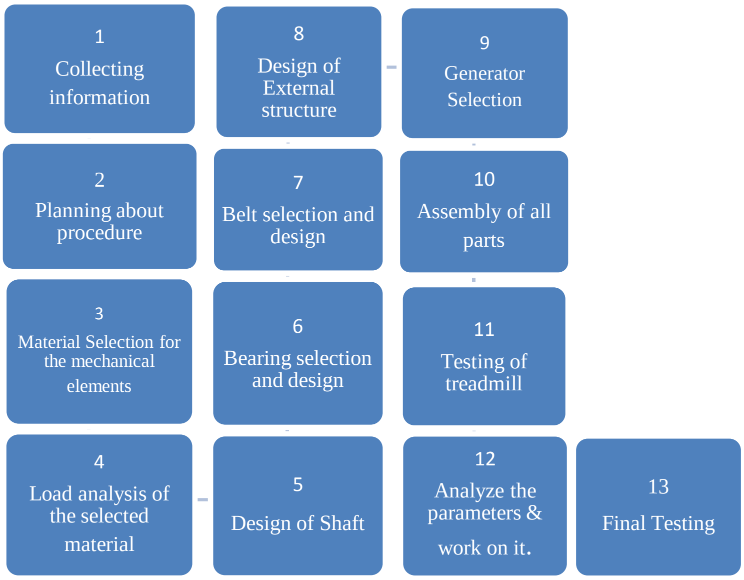

Fig. 2: Flowchart

3.2 Material selection:-

a) ShaftMaterial :- Designation = C45,

Condition = Tubes, Cold drawn and tempered,

Yield Tensile Strength (Syt) = 600 N/mm^2

Ultimate Tensile Strength (S_{ut}) = 700 N/mm^2

b) Bearing:-

Designation = 16006.

Bearing Material = Chrome Steel.

c) Bed Material:- Mild Steel.

d) Handle structure:- material = Aluminium

4. Calculations:-

4.1 Design of shaft

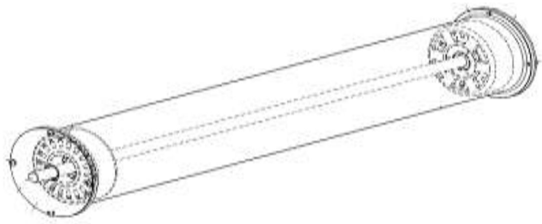

Fig.3: Structure of shaft

Maximum allowable load = 150 kg = 1471.5 N

Length of Shaft= 600 mm

Uniform distributed load= 2.4525 N/mm

Consider simply supported load

Material:-

Designation = C45

Condition = Tubes, cold drawn and tempered

Yield tensile strength (s_{yt}) = 600 N/mm^2

Ultimate tensile strength (S_{ut}) = 700 N/mm^2

$$T_p = 0.3 * S_{yt}$$

Where,

T_p = Permissible shear stress,

S_{yt} = Yield tensile strength.

$T_p = 0.3 * S_{yt} = 0.3 * 600$

$= 180$ N/mm^2

$$T_p = 0.18 * S_{ut}$$

Where , T_p = Permissible shear stress,

S_{ut} = Ultimate tensile strength.

$T_p = 0.18 * S_{ut}$

$T_p = 0.18 * 700$

$$T_p = 126 \text{ N/mm}^2$$

Select whichever smaller value , $T_p = 126$ N/mm^2

Assume, k_b=1.5 and k_t=1

$$P(KW) = \frac{2\pi NT}{60 * 10^6}$$

$$1.5 = \frac{2\pi T * 1500}{60 * 10^6}$$

T = 9549.29 N-mm.

M_{max} = (2.4525*600)*300

$$M_{max} = 441450 \text{ N-mm.}$$

As per ASME code,

$$\frac{\pi d^3 \mathrm{Tp}}{16} = \sqrt{(k_b * M)^2 + (k_t * T)^2}$$

$$\frac{\pi d^3 * 126}{16} = \sqrt{(1.5 * 441450)^2 + (1 * 9549.29)^2}$$

$$\frac{\pi d^3 * 126}{16} = 662243.852$$

$$d^3 = 26768.097$$

$$\mathrm{d} = 29.91$$

$$\mathrm{d} \simeq 30\mathrm{mm}$$

4.2 Bearing selection and design :-

Equivalent dynamic load is given by,

$$\mathrm{P} = \mathrm{X*V*Fr} + \mathrm{Y*Fa}$$

Where, P = equivalent dynamic load (N),

Fr = Radial load (N)

Fa = Axial or thrust load (N),

V = Race rotation factor

$$Fr = \frac{200 * 9.81}{4}$$

= 490.5 N

Hence, The bearing is subjected to Pure bearing load.

The value of V is 1.2 when the outer race rotates w.r.t. Load, while the inner race remains stationary.

Hence, New value of equivalent dyanamic load is given by,

$$\mathrm{P} = \mathrm{V} * \mathrm{Fr}$$

= 1.2*490.5

$$\mathrm{P} = 588.6\ \mathrm{N}.$$

Bearing life (L_{10}) :-

We take L_{10h}= 16000, From V.B.B table 15.2

$$L_{10} = \frac{60 \mathrm{n} L_{10h}}{10^6}$$

Where, n = Speed of rotation (rpm)

L_{10h} = Rated bearing life (hours)

L_{10} = Bearing life (mill.revln)

$$= \frac{60 * 1500 * 16000}{10^6}$$

$$\boxed{L_{10} = 1440 \text{ milli. Revolution}}$$

Then, We find Dynamic load capacity (C)

$$\boxed{C = P * (L_{10h})^{1/3}}$$

$$= 588.6\ (1440)^{1/3}$$

$$C = 4985.04 \text{ N}$$

From Table 15.5, We select bearing 16006.

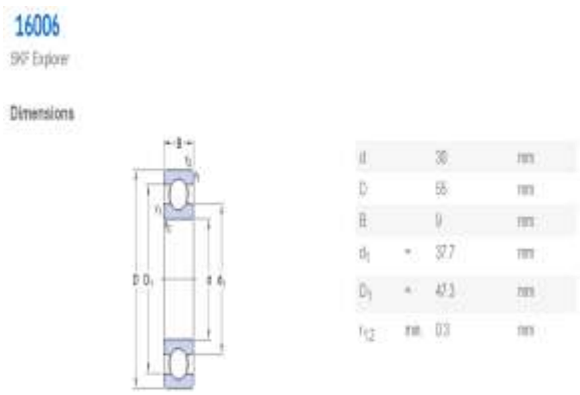

Fig.4: Bearing Specifications

Bearing Material: Chrome Steel

4.3 Belt selection and design:-

Fig.5 Flat Belt Mounted on Shaft

P = 1.5 KW

Load correction factor = 1.2

Maximum power = 1.2*1.5 = 1.8 KW

$$\boxed{\alpha_s = 180 - \frac{2\sin^{-1}(D-d)}{2C}}$$

$$\alpha_s = 180 - \frac{2\sin^{-1}(67-50)}{2 * 1520}$$

$$\alpha_s = 179.359$$

$$\alpha_s \simeq 180\,.$$

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Hence, arc of contact factor, $F_d = 1$

$$\text{Power corrected} = (KW)_{max} * F_d$$

$$= 1.8 * 1$$

$$= 1.8 \text{ KW}$$

Power corrected = 1.8 KW.

Assume n = 120 rpm not 1500 rpm as human being run on the belt to measure velocity.

Belt velocity is given by,

$$v = \frac{\pi * d * n}{60 * 10^3}$$

$$v = \frac{\pi * d * n}{60 * 10^3}$$

$$v = \frac{\pi * 67 * 130}{60 * 10^3}$$

$$v = 0.4560 \text{ m/s.}$$

$$\text{Corrected KW rating} = \frac{0.0118 * v}{5.08}$$

$$\text{Corrected KW rating} = \frac{0.0118 * 0.4560}{5.08}$$

$$\text{Corrected KW rating} = 1.0593 * 10^{-3}\text{KW.}$$

$$\text{width} * \text{plies} = \frac{\textit{corrected power}}{\textit{corrected belt rating}}$$

$$\text{width} * \text{plies} = \frac{1.8}{1.0593 * 10^{-3}}$$

$$\text{width} * \text{plies} = 1699.23$$

For 4 plies,

$$\text{width} = \frac{1699.23}{4}$$

$$\text{width} = 424.8 \text{ mm}$$

$$\text{width} = 43 \text{ cm.}$$

$$\text{Width} \simeq 43 \text{ cm.}$$

Length of Belt is given by,

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C}$$

$$L = 2 * 1260 + \frac{\pi(67+67)}{2} + \frac{(67-67)^2}{4 * 1520}$$

$$L = 2730.48 \ mm$$

$$L = 273 \text{ cm.}$$

5. Objective

- To understand the construction and working of existing treadmill.
- To elaborate and discuss the modified design with respect to generation of electricity by using mechanical energy.
- To design different mechanical components to receive maximum mechanical energy to generate electricity.
- To provide a treadmill with Electricity Generator to reduce the pollution at some extent by saving energy.
- Modify the design data with respect to material properties, cost analysis, performance analysis, aesthetic and ergonomics as well as future scope.
- Develop or manufacturing the modified treadmill as per requirement.
- To provide a treadmill with Electricity Generator. This is simple in design.
- To produce a treadmill with Electricity Generator at low cost.
- Analyze the modified result with respect to existing result of the treadmill.

6. Table :-

Components	Formulae	Selected Dimentions
Shaft	$\frac{\pi d^3 Tp}{16} = \sqrt{(k_b * M)^2 + (k_t * T)^2}$	d = 30 mm
Bearing	$P = X*V*Fr + Y*Fa$ $L_{10} = \frac{60 n L_{10h}}{10^6}$ $C = P * (L_{10h})^{1/3}$	Designation of Bearing 16006
Belt	$v = \frac{\pi * d * n}{60 * 10^3}$ $width * plies = \frac{corrected\ power}{corrected\ belt\ rating}$ $L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C}$	W= 43 cm L= 273 cm

6. Cost Analysis :-

- By considering all elements both mechanical and electrical and electronics cost as 15 to 20 thousand approximately is required for this treadmill.
- To reduce the cost cheap but high strength of material have to use.

7. Result :-

Sr.No.	Components	Dimension
1	Shaft	d = 30 mm
2	Roller	D = 67 mm
		d = 55 mm
3	Bearing	Selected Bearing
		16006 (Deep groove ball bearing)
4	Belt	L = 2730 mm
		W = 430 mm

8. Future Scope :-

- Use of this treadmill in gym and fitness centers, by this we can generate electricity to lighten up the premises.
- Use to charge the battery by this modify treadmill.
- Run LED bulbs and electrical instruments.

9. Conclusion :-

- Electrical energy can be saved by using this manual treadmill with Electricity Generator**.**
- This manual treadmill with Electricity Generator is less expensive.
- A wide range of health problems can be managed using this manual treadmill.
- This treadmill with Electricity Generator is useful for such areas where electricity is not available.
- Strength of muscles can be improved by using this manual treadmill.

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